SAGA

The Soil Science & Archaeo-Geophysics Alliance

PRINCIPLES AND APPLICATIONS OF GPR SURVEY METHODS FOR ARCHAEOLOGY

ROGER SALA
SOT Archaeological Prospection

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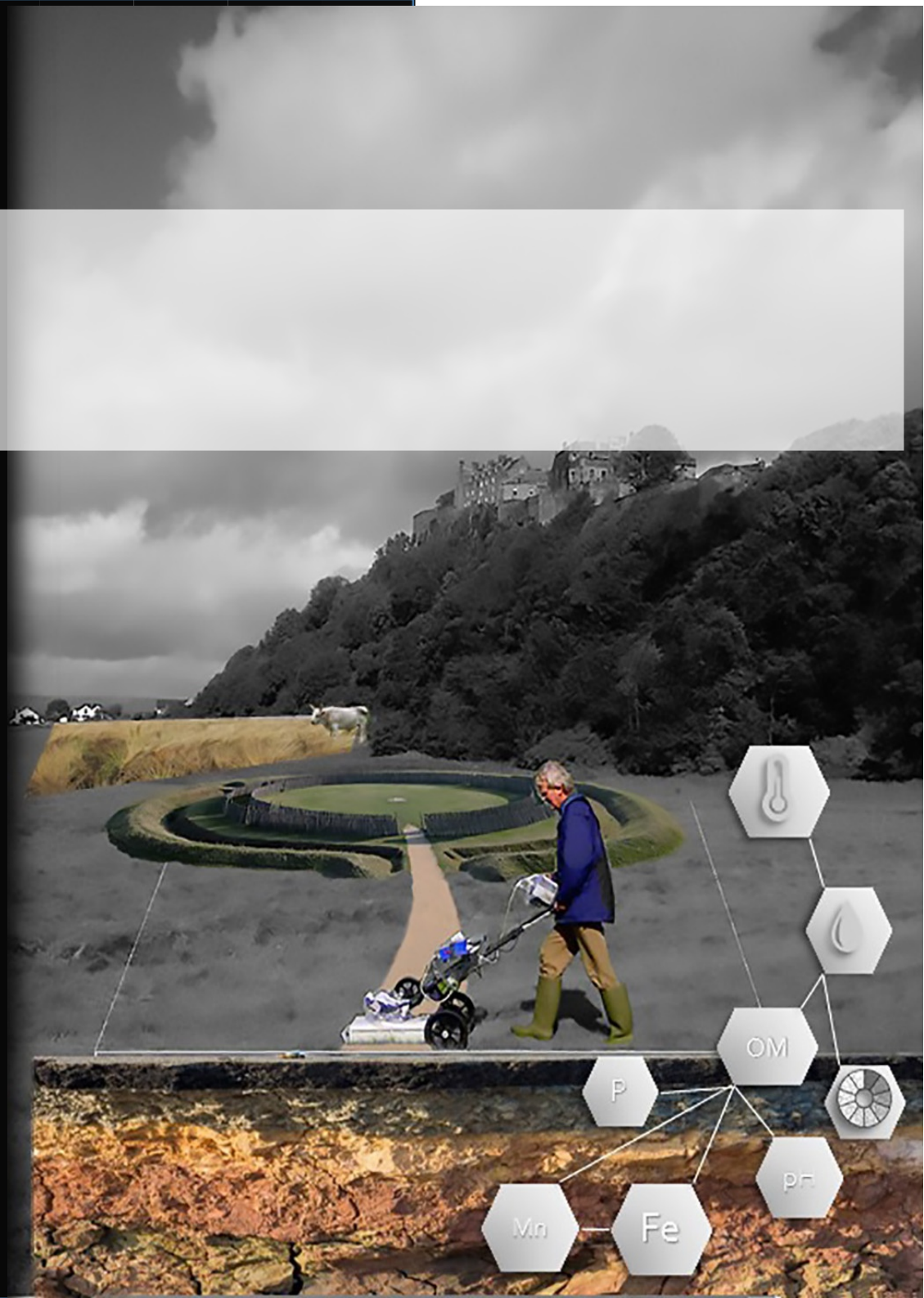
29 Jul - 2 Aug 2019, Auritz/Burguete



PRINCIPLES AND APPLICATIONS OF GPR SURVEY METHODS FOR ARCHAEOLOGY

A-GPR. HOW IT WORKS?

-OPERATION PRINCIPLES

-WAVES, FREQUENCY AND TIME .TRAVELLING THROUGH THE SOILS

B-GPR AND ITS LIMITATIONS. ENVIRONMENTS AND SOILS.

-SOILS: DIELECTRIC PROPRIETIES AND CONDUCTIVITY.

-INFLUENCE OF ENVIRONMENTAL CONDITIONS

-SAME SOILS, DIFFERENT RESPONSE? INFLUENCE OF WEATHERING, AGRICULTURE, AND ARCHAEOLOGICAL CONTEXT

-DETECTING ARCHAEOLOGICAL OBJECTS. GPR IS NOT PANACEA

C-GPR DATA

-FROM 2D TO 3D

-DATA PROCESSING: NOSIE AND SHAPE

-REPRESENTING DATA

D-GPR SURVEY APPLIED TO ARCHAEOLOGY

-PLANNING A GPR SURVEY. CONTEXT, FREQUENCY, DEPTH AND RESOLUTION

-INTERPRETING DATA. UNDERSTANDIG DATA AND ITS CONTEXT

-COMUNICATING RESULTS

E-CONCLUSION

A-GPR. HOW IT WORKS?

-OPERATION PRINCIPLES

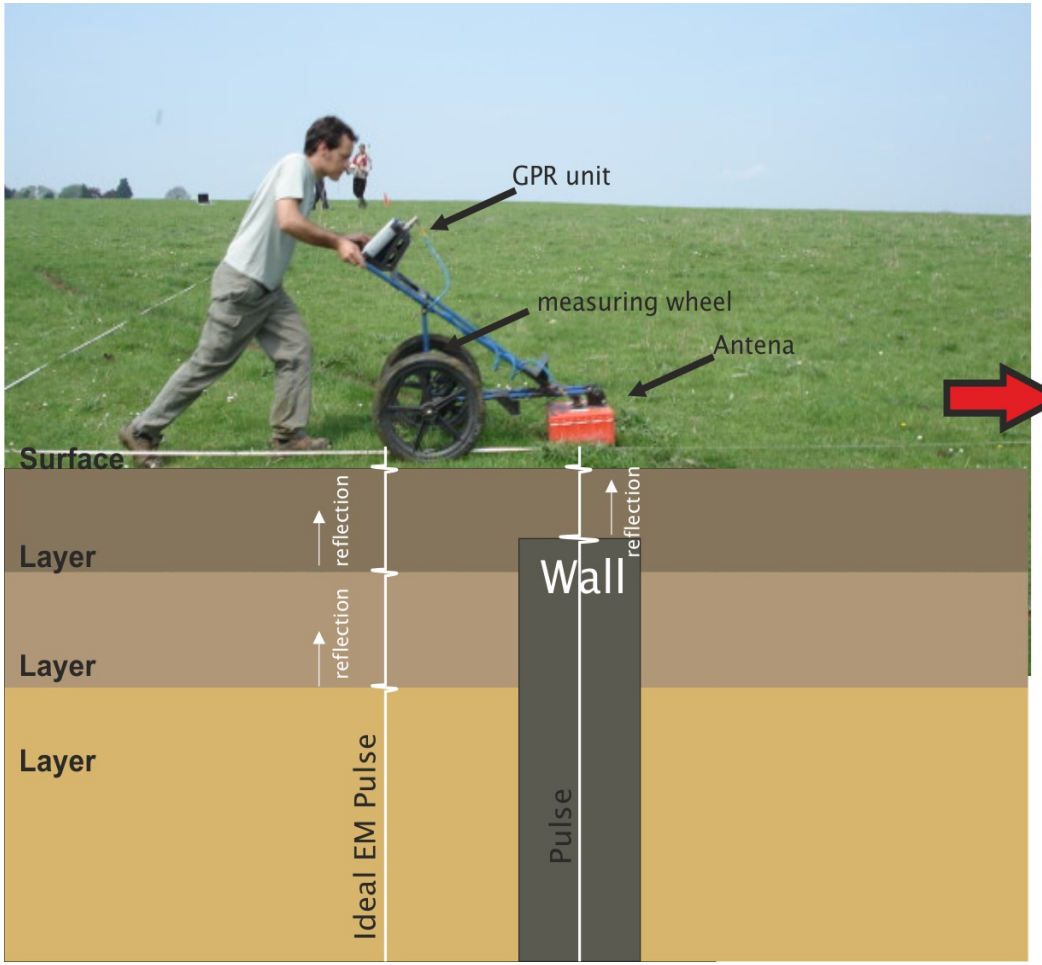
-WAVES, FREQUENCY AND TIME .TRAVELLING THRU THE SOILS

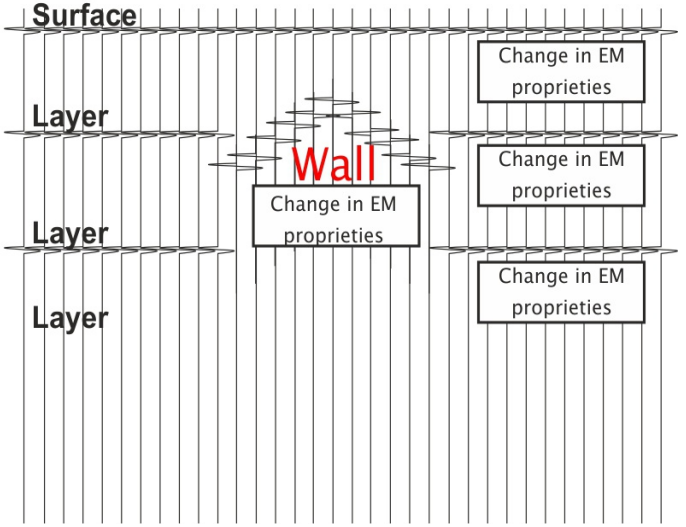
-NOWADAYS GPR SYSTEMS

A-GPR. HOW IT WORKS?

OPERATION PRINCIPLES

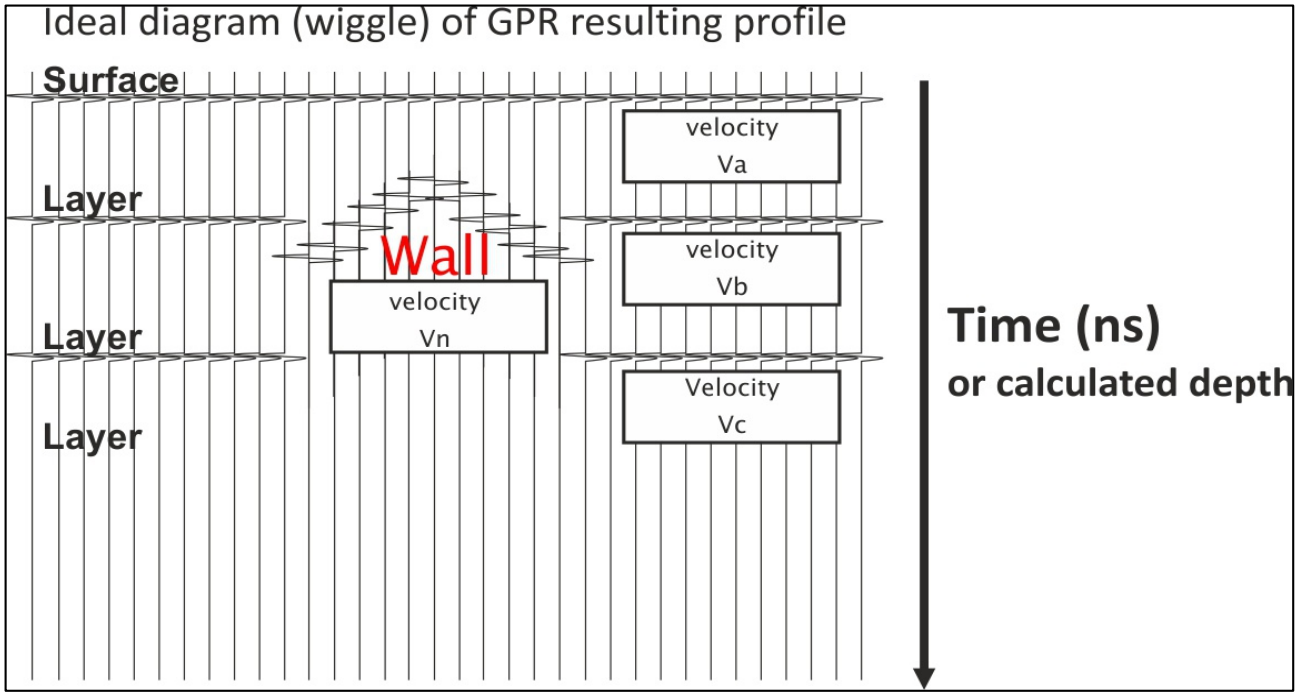
GROUND PENETRATING RADAR IS A SURVEY METHOD BASED ON THE EMISION AND RECEPTION THROUGH THE GROUND OF EM PULSES OF KNOWN FREQUENCY AND DURATION PARAMETRS.





A-GPR. HOW IT WORKS?
OPERATION PRINCIPLES

THE GPR DEVICES EMIT EM (DIREECTIONAL) PULSES THRU THE GROUND AND RECORD THE RELFECTIONS GENERATED BY CHANGES IN THE PROPRIETIES OF THE SOIL.



A PART OF THE PULSE ENERGY IS REFLECTED BACK TO THE SURFACE AND RECORDED BY THE RECIVER ANTENNA. PART OF THE ENERGY COULD 'CONTINUE' ITS TRAVEL AND REPRODUCE THE SAME PROCESS UNTIL THE ATTENUATION OF ENERGY PRODUCE NO DETEECTABLE SIGNAL.

THE TIME BETWEEN THE EMISION AND RECEPTION OF RELFECTIONS COULD BE USED TO INFER THE DISTANCE (DEPTH) OF THE OBJECTS THAT GENERATE THEM

THE REPRETITION OF THAT SEQUENCE ALLOW TO GENERATE 'SECTIONS' OF THE SOIL. THE SECTIONS, KNOWN AS RADARGRAMS, REPRESENT IN TWO AXLES THE EXPLORED DISTANCE (X) AND THE DELAY IN REFLCETIONS (TIME) OR CALCULATED DEPTH (Z).

A-GPR. HOW IT WORKS?
OPERATION PRINCIPLES

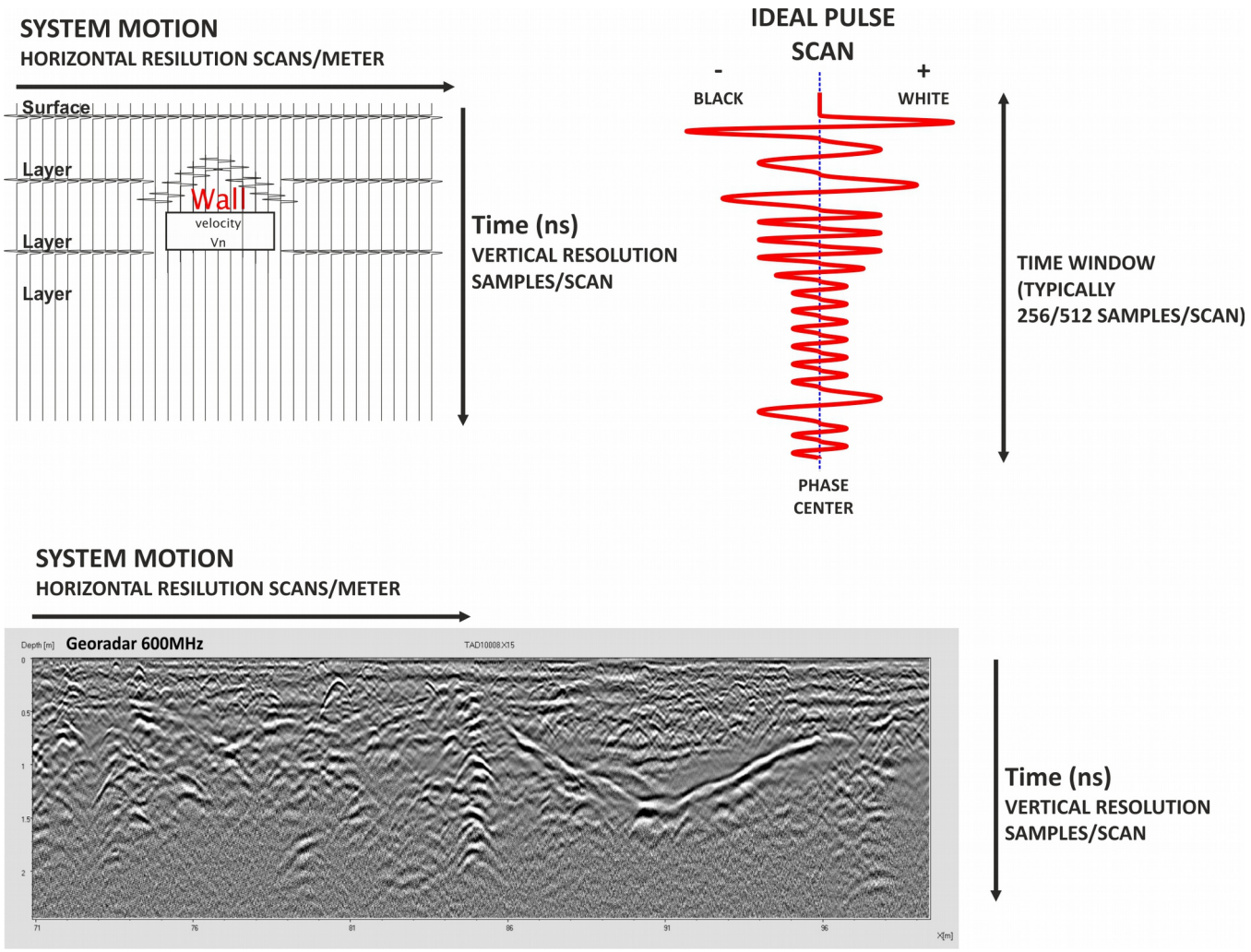
DATA FORMAT AND RESOLUTION

THE DATA COLLECTED CONSISTS IN SCANS THAT CONTAIN SAMPLES

A SCAN CORRESPONDS TO THE ENTIRE PULSE OF A SPECIFIED TIME TIME WINDOW

EACH SCAN IS DIVIDED IN TIME **SAMPLES**. TYPICALLY 256-512 SAMPLES PER SCAN

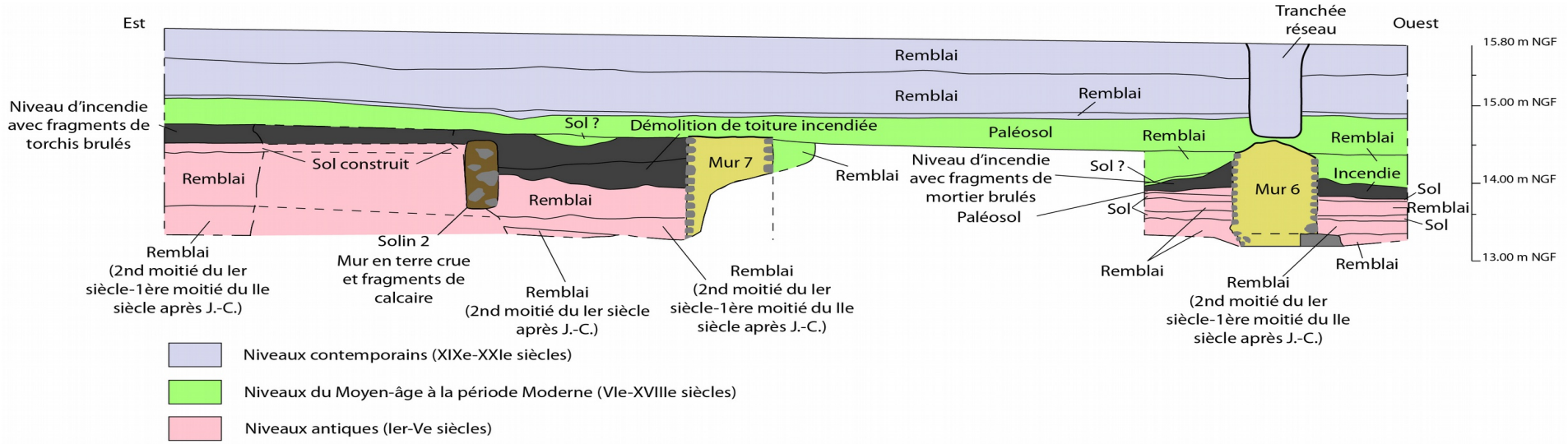
RADARGRAMS SHOW +/- WAVE OSCILATIONS AS BLACK-WHITE GRAYSCALE OR OTHE COLOR SCALES



A-GPR. HOW IT WORKS?

FREQUENCY AND TIME . TRAVELLING THRU THE SOILS

THE SHALLOWER LAYERS OF EARTH ARE A COMPLEX MEDIA. ARCHAEOLOGICAL ENVIRONMENTS COULD CONTAIN MANY VARIATIONS IN SOIL COMPOSITIONS AND PHYSICAL PROPRIETIES.



GPR PULSES REACT TO CHANGES IN DIELECTRIC PROPRIETIES OF SOILS AND OBJECTS IN THE SUBSURFACE.

..BUT THE REACTION ALSO MEANS CHANGES IN THE VELOCITY, ENERGY AND FREQUENCY OF THE EM PULSES.

A-GPR. HOW IT WORKS?
FREQUENCY AND TIME . TRAVELLING THRU THE SOILS

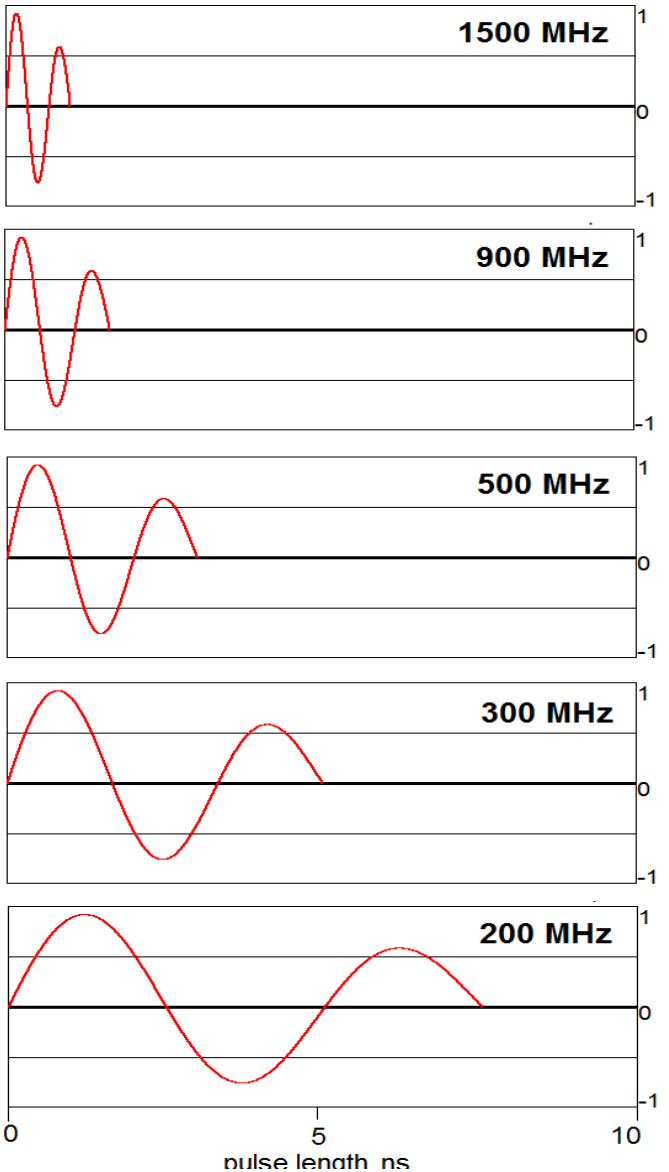
LOWER FREQUENCY ANTENNAE TEND TO OFFER A BETTER PERFORMANCE IN DEPTH BUT A LOW DETAIL IN DESCRIPTION OF OBJECTS.

HIGHER FREQUENCIES TEND TO ATTENUATE (LOSS OF ENERGY) RAPIDLY WITH DEPTH BUT A HIGHER DETAIL IN THE DETECTION OF OBJECTS.

HAVING THIS IN MIND, BOTH THE GPR PULSES FREQUENCY AND THE PROPRIETIES SOIL MEDIA ARE DECISIVE IN THE PERFORMANCE OF GPR.

WE NEED FREQUENCIES THAT ALLOW TO REACH THE DEPTH OF ARCHAEOLOGICAL LAYERS.

WE NEED FREQUENCIES CAPABLE TO DESCRIVE ARCHAEOLOGICAL OBJECTS



USE OF GPR IN ARCHAEOLOGICAL ENVIRONMENTS

B-GPR. ENVIRONMENTS AND AND SOILS

-SOILS: DIELECTRIC PROPRIETIES AND CONDUCTIVITY

-SAME SOILS, DIFFERENT RESPONSE? INFLUENCE OF WEATHERING, AGRICULTURE, AND ARCHAEOLOGICAL CONTEXT

-DETECTING ARCHAEOLOGICAL OBJECTS. GPR IS NOT PANACEA

B-GPR. ENVIRONMENTS AND AND SOILS

-SOILS: DIELECTRIC PROPRIETIES AND CONDUCTIVITY

GPR PERFORMANCE DEPENDS ON THE COMPOSITION OF THE MEDIA WHERE IS APPLIED.
BUT TO WHAT SOIL PROPRIETIES/PARAMETERS?

DIELECTRIC PERMITIVITY *DESCRIBES DE CAPACITY OF A MATERIAL TO STORE AND RELEASE EM ENERGY IN THE FORM OF ELECTRIC CHARGE* (VERDONCK).

THE DIECLECTRIC PERMITIVITY OF MATERIALS VARY WITH THE WATER CONTENT.

THE DIELECTRIC PERMITIVITY ALSO CONDITION THE PROPAGATION VELOCITY OF EM WAVES.

Material	ε_r; Davis and Annan (1989)	ε_r; Daniels (1996)	Velocity (m/ns)	Velocity (ft/ns)
Air	1	1	0.3	0.98
Distilled water	80		0.03	0.11
Fresh water	80	81	0.03	0.11
Sea water	80		0.03	0.49–0.57
Fresh water ice	3–4	4	0.15–0.17	0.35–0.49
Sea water ice		4–8	0.11–0.15	0.28–0.35
Snow		8–12	0.09–0.11	0.35–0.50
Permafrost		4–8	0.11–0.16	0.40–0.57
Sand, dry	3–5	4–6	0.12–0.17	0.18–0.31
Sand, wet	20–30	10–30	0.05–0.09	0.57–0.70
Sandstone, dry		2–3	0.17–0.21	0.31–0.44
Sandstone, wet		5–10	0.09–0.13	0.35–0.49
Limestones	4–8		0.11–0.15	0.37
Limestone, dry		7	0.11	0.35
Limestone, wet		8	0.11	0.25–0.44
Shales	5–15		0.08–0.13	0.33–0.40
Shale, wet		6–9	0.10–0.12	0.18–0.44
Silts	3–30		0.05–0.13	0.16–0.44
Clays	5–40		0.05–0.13	0.16–0.44
Clay, dry		2–6	0.12–0.21	0.40–0.70
Clay, wet		15–40	0.05–0.08	0.16–0.25
Soil, sandy dry		4–6	0.12–0.15	0.40–0.49
Soil, sandy wet		15–30	0.05–0.08	0.18–0.25
Soil, loamy dry		4–6	0.05–0.08	0.40–0.49
Soil, loamy wet		15–30	0.07–0.09	0.22–0.31
Soil clayey dry		4–6	0.12–0.15	0.40–0.49
Soil, clayey wet		10–15	0.08–0.09	0.25–0.31
Coal, dry		3.5	0.16	0.53
Coal, wet		8	0.11	0.35
Granites	4–6		0.12–0.15	0.40–0.49
Granite, dry		5	0.13	0.44
Granite, wet		7	0.11	0.37
Salt, dry	5–6	4–7	0.11–0.15	0.37–0.49

B-GPR. ENVIRONMENTS AND AND SOILS

-SOILS: DIELECTRIC PROPRIETIES AND CONDUCTIVITY

THE CONDUCTIVITY DESCRIVES THE ABILITY OF A MATERIAL TO PASS FREE ELECTRIC CHARGES WHEN AN ELECTRIC FIELD IS APPLIED. IN SOILS IT RELATES TO THE CONCENTRATION OF WATER-SOLUBLE SALTS (VERDONCK).

CONDUCTIVE MATERIALS, ESPECIALLY CLAY TEND TO ATTENUATE THE ENERGY OF EM PULSES.

MATERIAL	K	σ (mS/m)	v (m/ns)	a (dB/m)
Air	1	0	0.30	0
Distilled Water	80	0.01	0.033	2x10-3
Fresh Water	80	0.5	0.033	0.1
Sea Water	80	3x103	.01	103
Dry Sand	3-5	0.01	0.15	0.01
Saturated Sand	20-30	0.1-1.0	0.06	0.03-0.3
Limestone	4-8	0.5-2	0.12	0.4-1
Shales	5-15	1-100	0.09	1-100
Silts	5-30	1-100	0.07	1-100
Clays	5-40	2-1000	0.06	1-300
Granite	4-6	0.01-1	0.13	0.01-1
Dry Salt	5-6	0.01-1	0.13	0.01-1
Ice	3-4	0.01	0.16	0.01

Dielectric constant, conductivity, velocity and attenuation at 100 MHz for various geologic materials (DAVIS & ANNAN 1989)

B-GPR. ENVIRONMENTS AND AND SOILS

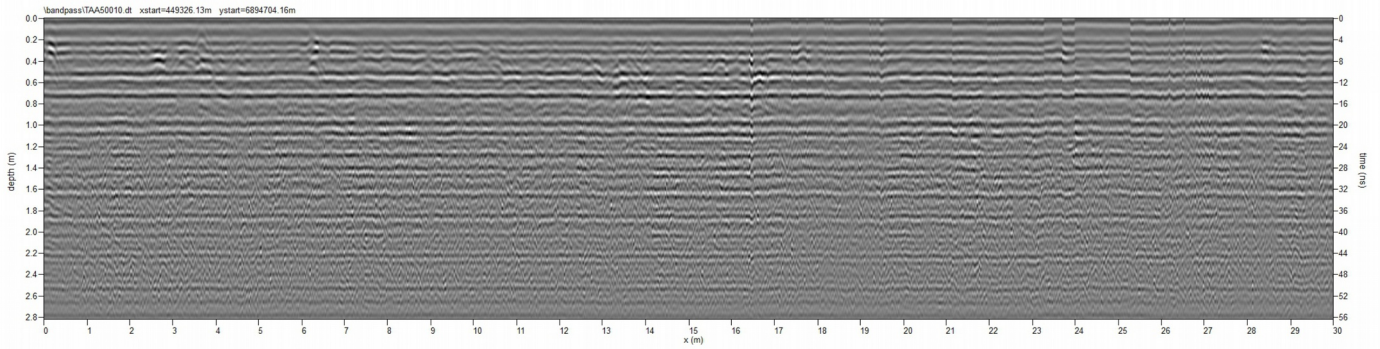
-SOILS: DIELECTRIC PROPRIETIES AND CONDUCTIVITY

HAVING THE TWO PARAMETERS INTO ACCOUNT WE CAN DEDUCE

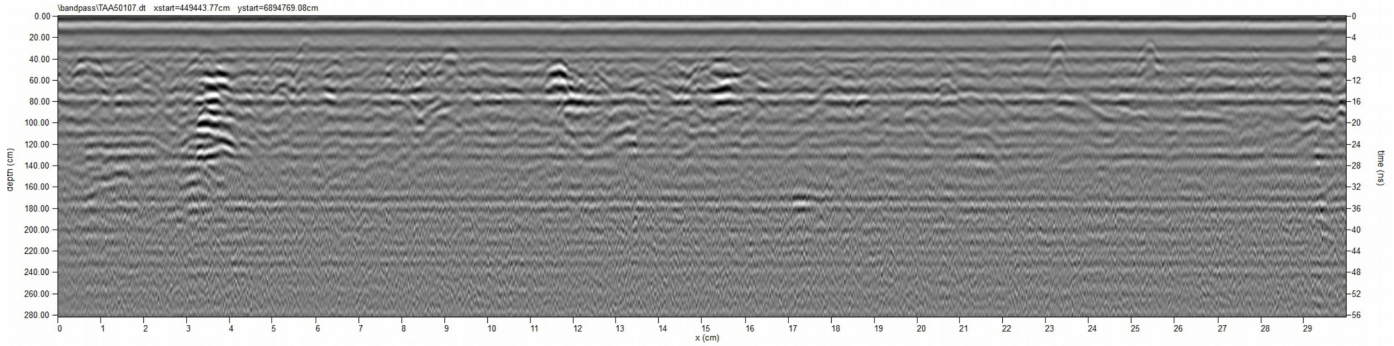
-GPR PERFORMANCE IS HIGHLY DEPENDENT ON LOCAL GEOLOGY AND SURFACE CONDITIONS

-GPR CAN PRODUCE DIFFERENT DATA RESULTS IN THE SAME SITE DEPENDING ON NON CONSTANT PARAMTERS (WATER AND CLAY CONTENTS OF SOILS).

CULTIVATION FIELD. DRY, RECENTLY HARVESTED (JULY 2017)



FLAT, GRASS SURFACE. PASTURAGE FIELD (JULY 2016)



B-GPR. ENVIRONMENTS AND AND SOILS

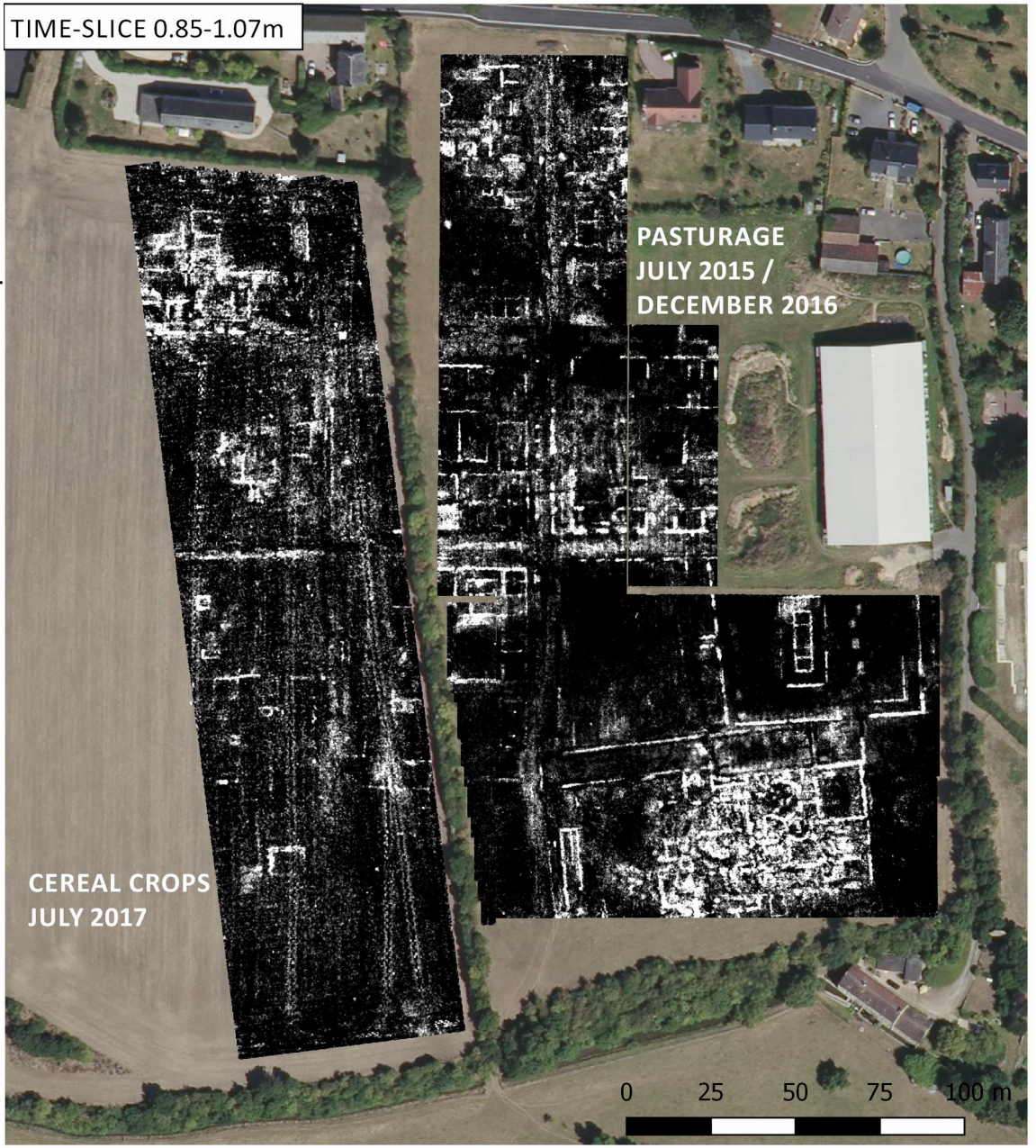
-SAME SOILS, DIFFERENT RESPONSE? INFLUENCE OF WEATHERING, AGRICULTURE, AND ARCHAEOLOGICAL CONTEXT

A NUMBER OF ENVIRONMENTAL OR ANTROPIC CHANGES HAVE AN INLFUENCE IN DIELECTRIC PERMITTIVITY AND CONDUCTIVITY OF ARHCAEOLOGICAL ENVIRONMENTS.
THEESE FACTORS SHOULD BE TAKEN INTO ACCOUNT WHEN EVALUATING EFECTIVITY OF A GPR SURVEY.

WHEATHER:
WATER CONTENTS
TEMPERATURE

AGRICULTURAL WORKS:
PLOUGH WORKS (COMPACTION AND POROSITY)
FERTILIZERS (SALT CONTENTS)
PASTURAGE (COMPACTION, SALT CONTENTS IF INTENSIVE)

URBAN SOILS:
WATER CONTENTS+HETROGENITY

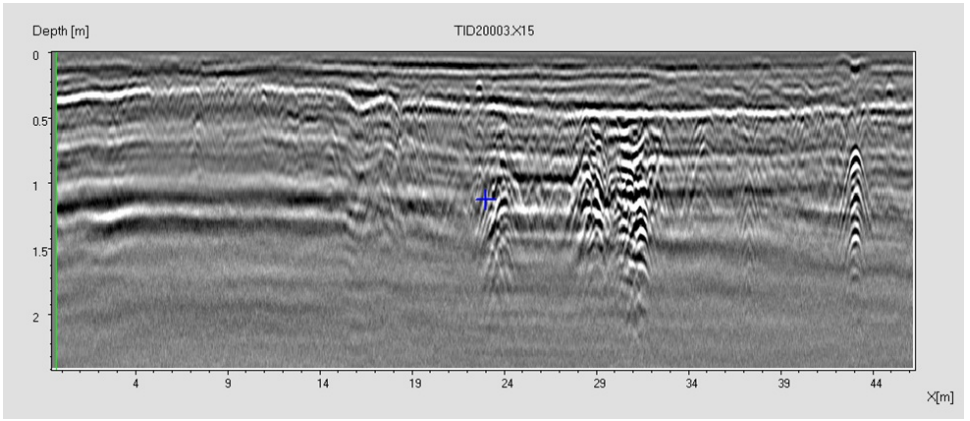


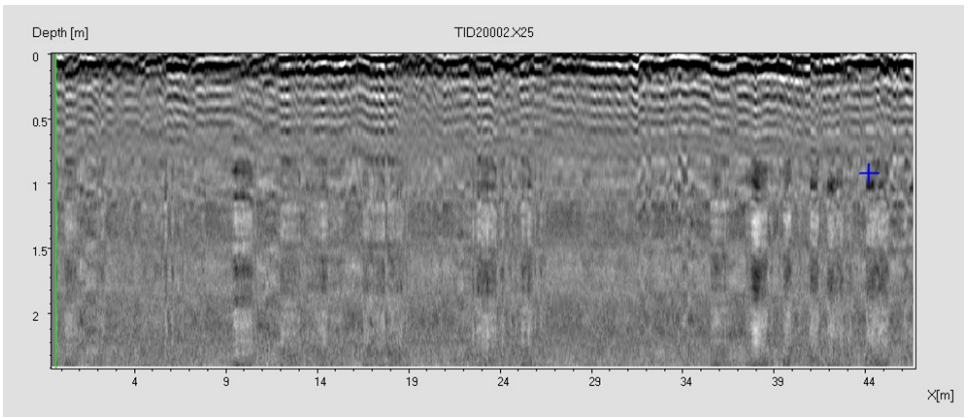
B-GPR. ENVIRONMENTS AND AND SOILS

-SAME SOILS, DIFFERENT RESPONSE? INFLUENCE OF WEATHERING, AGRICULTURE, AND ARCHAEOLOGICAL CONTEXT

...AND ALSO THE ANTENNA CONTACT WITH THE GROUND SURFACE HAS A CRITICAL INFLUENCE IN THE DATA QUALITY.

UNREGULAR SURFACES TEND TO SPREAD ENERGY OF PULSES AND TO PRODUCE COUPLING NOISES





B-GPR. ENVIRONMENTS AND AND SOILS

-DETECTING ARCHAEOLOGICAL OBJECTS. GPR IS NOT PANACEA

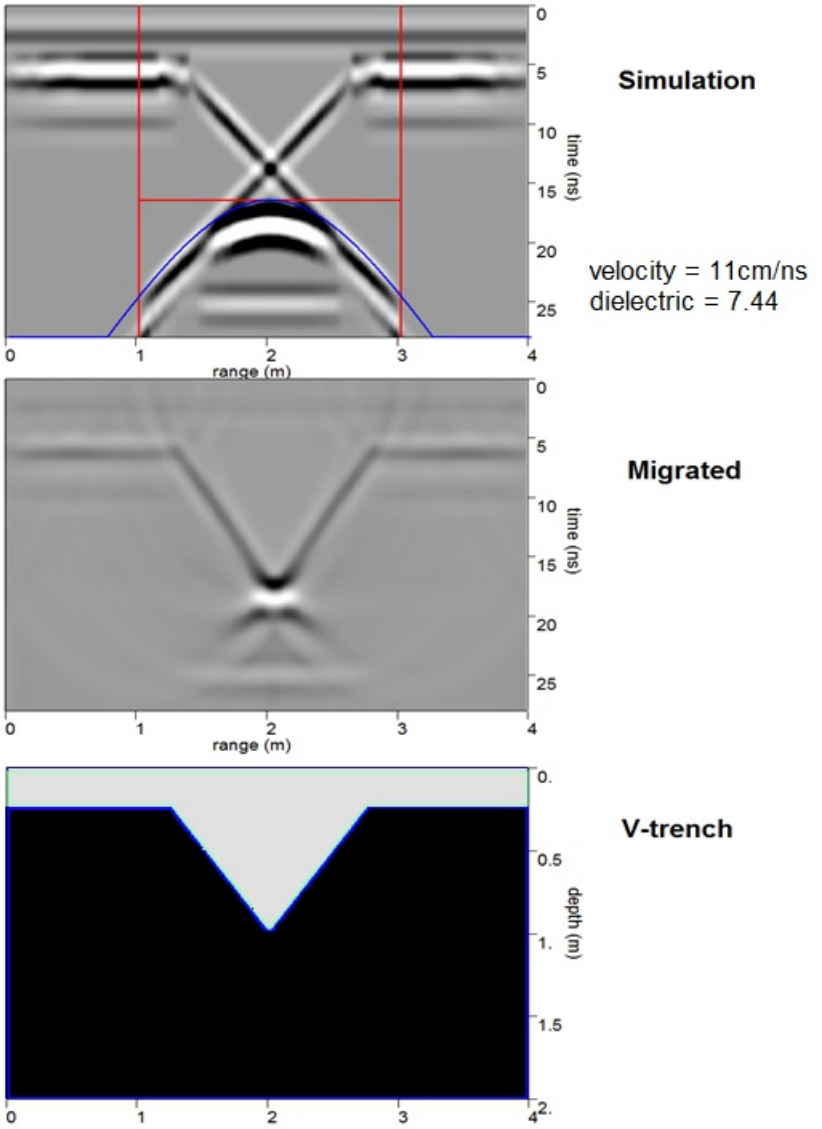
GPR IS SENSIBLE TO MANY ARCHAEOLOGICAL FEATURES. BUT NOT EVEYTHING CAN BE DETECTED.

FREQUENCY DETERMINES THE SIZE OF OBJECTS WE CAN DETECT.

THE **DISPOSITION** OF OBJECTS AND THEIR **GEOMETRY** HAVE AN INFLUENCE IN THE IMAGES WE CAN PRODUCE. ARTIFATCS

THE PHYSICO-CHEMICAL COMPOSITION OF SOME ARCHAEOLOGICAL OBJECTS COULD GENERATE ANOMALIES SUBJECT TO CHANGES DEPENDING ON VARIABLE SOIL CONDITIONS

DATA PROCESSING COULS ALSO PRODUCE 'FALSE' MAGES



FROM GOODMAN AND PIRO 2012

C-GPR DATA

-FROM 2D TO 3D

-DATA PROCESSING: NOSIE AND SHAPE

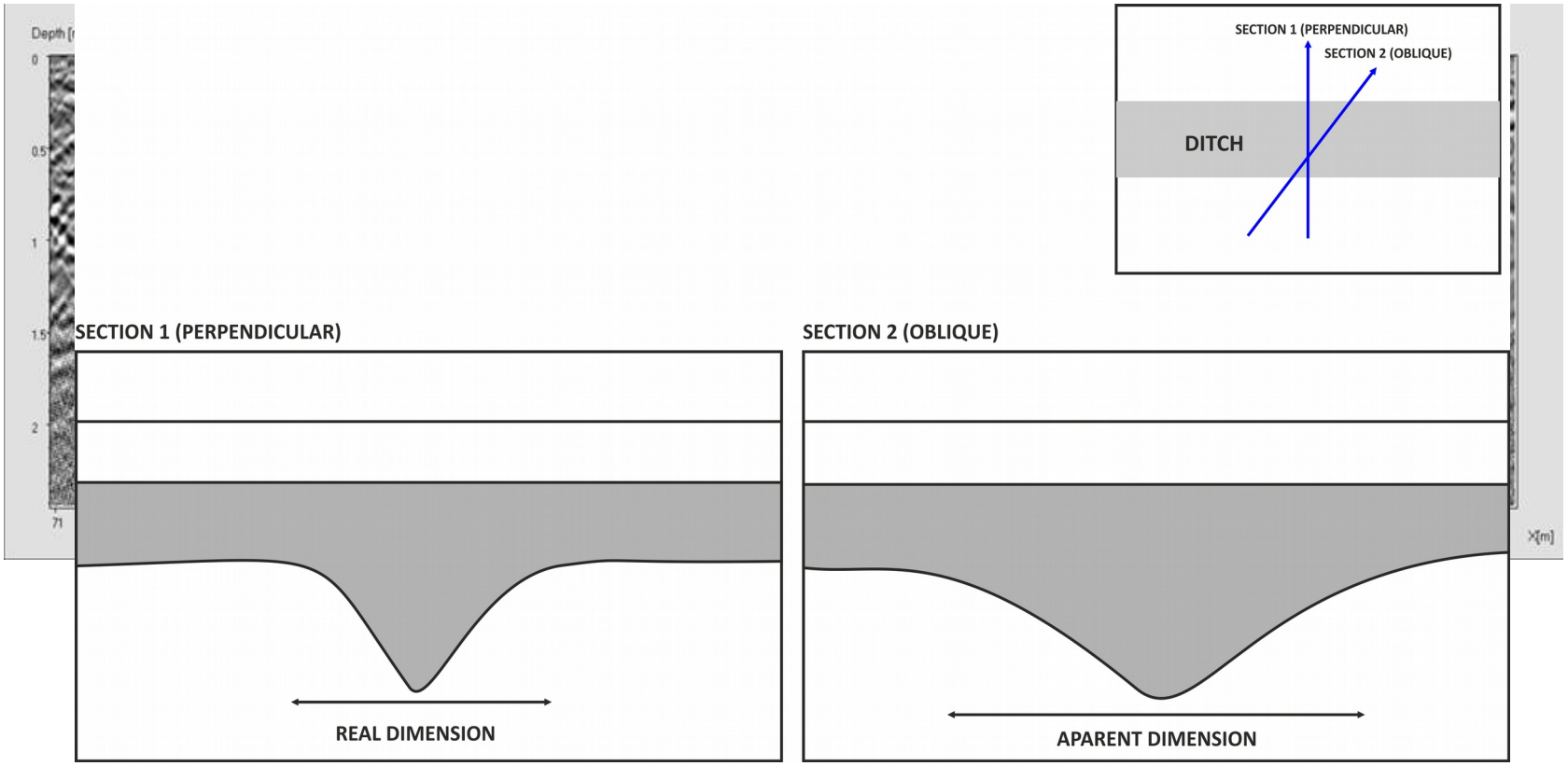
-REPRESENTING DATA

C-GPR SURVEY
-FROM 2D TO 3D

THE GPR SECTIONS OR RADARGRAMS ARE 2D INFORMATION, REPRESENTING TWO DIMENSIONS (X/Z).

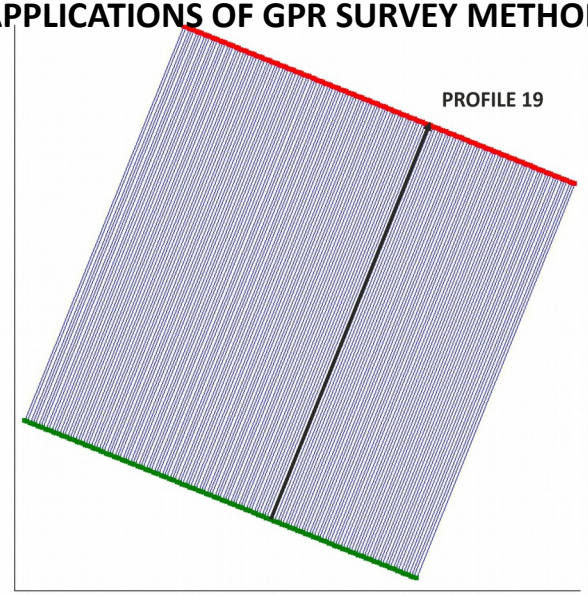
THE INTERPRETATION OF RADARGRAMS IS TRICKY: THEY REPRESENT REFLECTIONS, NOT OBJECTS.

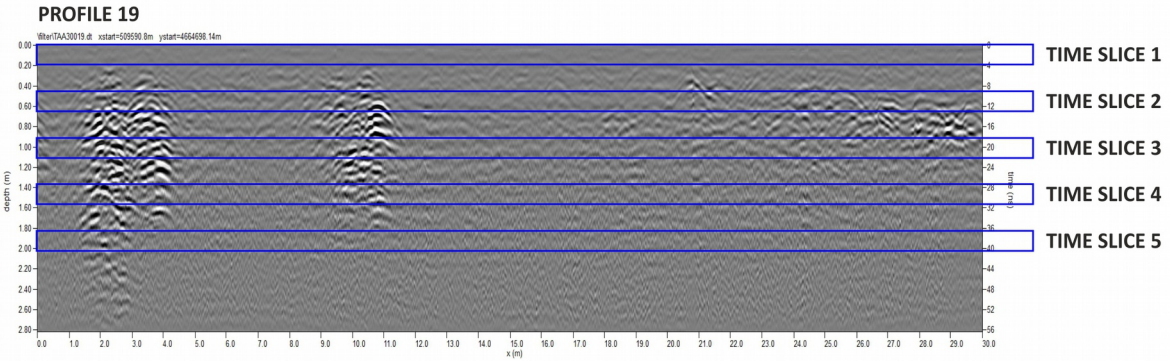
THE REAL SHAPE OR TRAJECTORY OF OBJECTS COULD NOT BE INFERED FROM A SINGLE PROFILE.

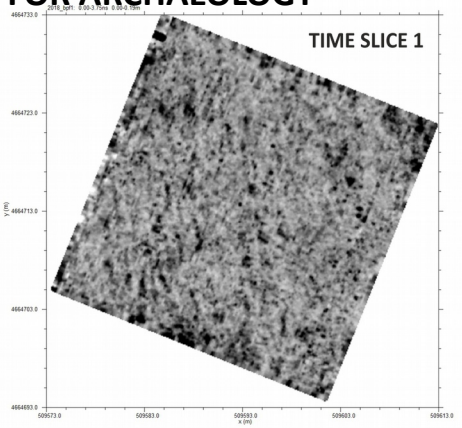


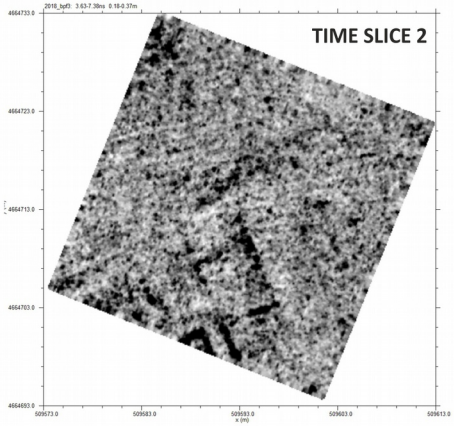
PRINCIPLES AND APPLICATIONS OF GPR SURVEY METHODS FOR ARCHAEOLOGY

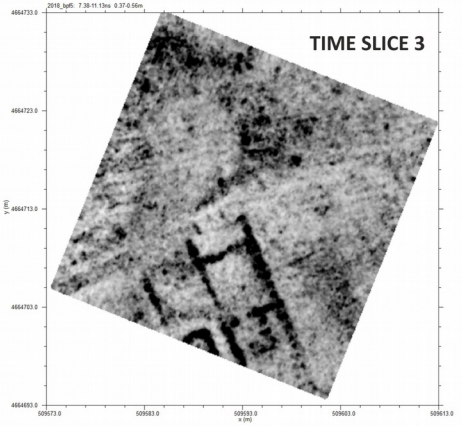
C-GPR SURVEY
-FROM 2D TO 3D.
TIME-SLICING

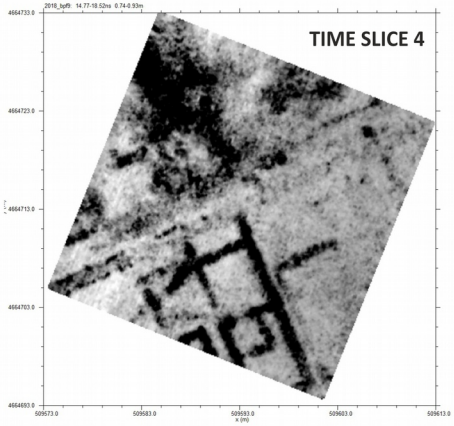


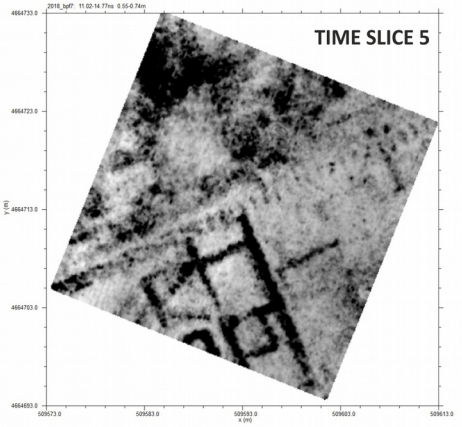












A SUBSTANCIAL CHANGE IN THE USE OF GPR HAS BEEN PRODUCED IN THE LATE 1990'S, WHEN THE **TIME-SLICE** TECHNIQUE WAS DEVELOPED TO BE APPLIED IN ARCHAEOLOGICAL SURVEYS.

THE TECHNIQUE CONSISTS IN INTERGRATING A NUMBER OF 2D FILES (SECTIONS) OF KNOWN POSITION IN A 3D MATRIX, WHICH IS USED TO CREATE PLANAR VIEWS AT SEVERAL TIME (OR DEPTH) RANGES.

C-GPR SURVEY

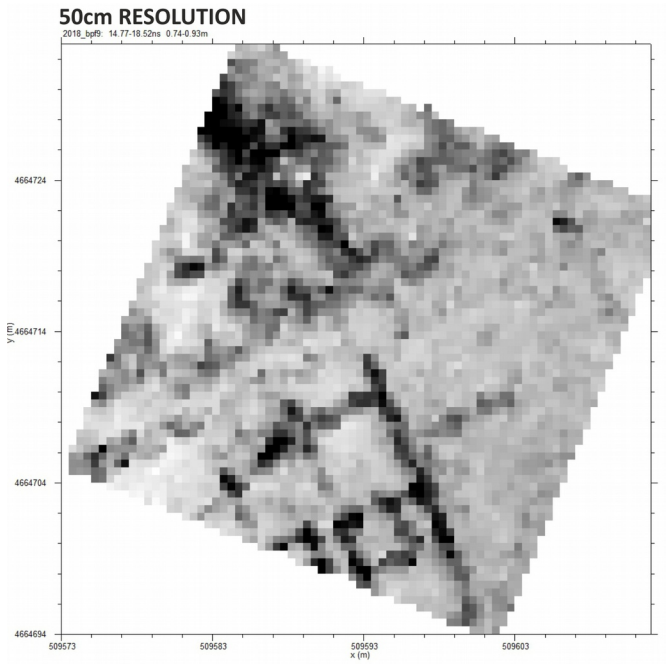
-FROM 2D TO 3D.

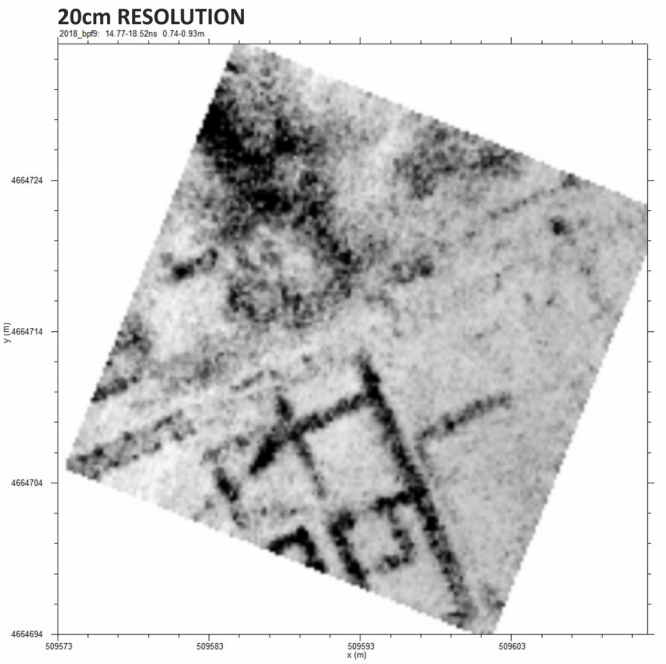
TIME-SLICING AND RESOLUTION

...BUT AREA SURVEYS AND TIME-SLICE TECHNIQUE MADE MORE EVIDENT THE VALUE OF SPATIAL RESOLUTION OF DATA

MORE RESOLUTION=MORE DATA
MORE DATA= MORE SENSOR STABILITY NEEDED

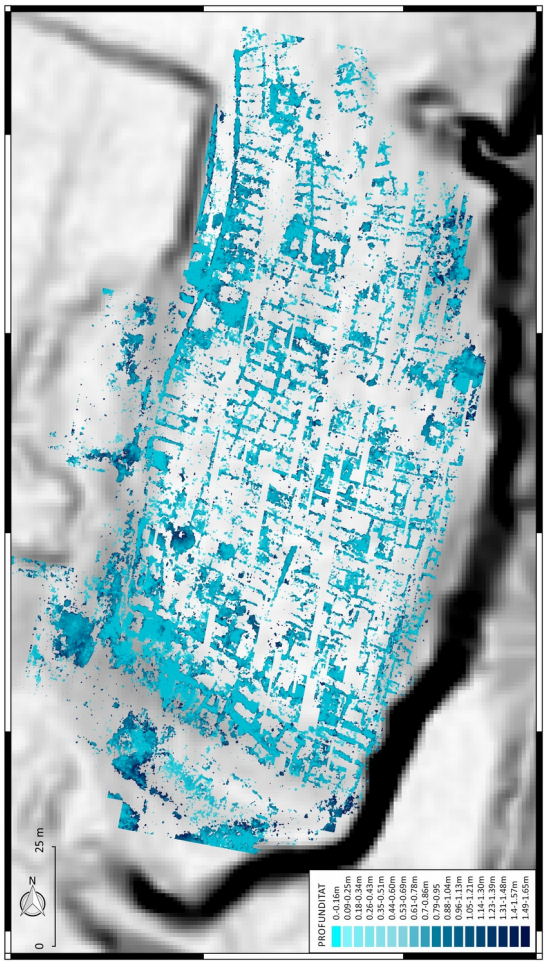
A GOOD RULE IS: WE CANNOT PRETEND TO IMAGE STRUCTURES SMALLER THAN OUR LINE RESOLUTION





C-GPR SURVEY
-FROM 2D TO 3D

THIS FORMAT OPENED A NEW WINDOW IN THE COMUNICATION OF DATA RESULTS AND IN THE PARTICIPATION OF ARCHAEOLOGISTS IN THE DATA INTRPRETATION.
ALSO, PLANAR OR Z CUTS ALLOW TO EXAMINE MUCH MORE DATA IN A SAME VISUAL CONTEXT, WHICH RESULTS IN A RICHER INTERPRETATION POSSIBILITIES



C-GPR SURVEY

-DATA PROCESSING. NOISE AND SHAPE

GPR DATA PROCESSING TO PRODUCE TIME-SLICES
ON GPR-SLICE SOFTWARE

A. DATA FORMAT
B. DATA POSITIONING INFO FILE

PROCESSING SINGLE PROFILES
A. GAINING DATA / CENTERING WAVE
B.BACKGROUND FILTERING
C. MIGRATION (VELOCITY ESTIMATION)

INTEGRATING 2D DATA INTO A 3D BLOCK
A. TIME-SLICE PARAMETERS
B. LINE-NOISE CORRECTION
C. GRIDDING

VISUALISATION
A. TIME-SLICES
D. CREATING 3D VIEWS

A-GPR. HOW IT WORKS?
OPERATION PRINCIPLES

DATA FORMAT AND RESOLUTION

THE DATA COLLECTED CONSISTS IN SCANS THAT CONTAIN SAMPLES

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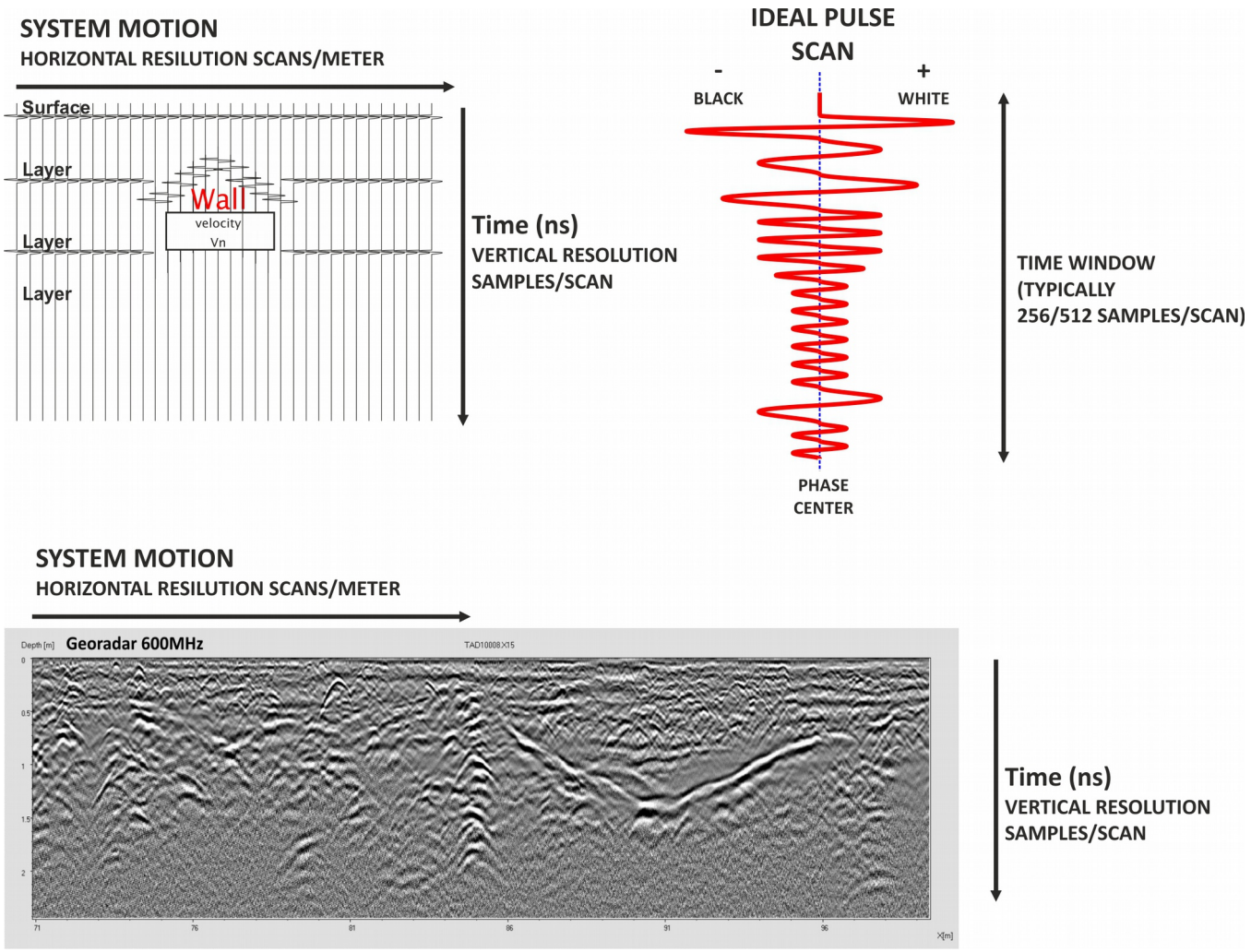
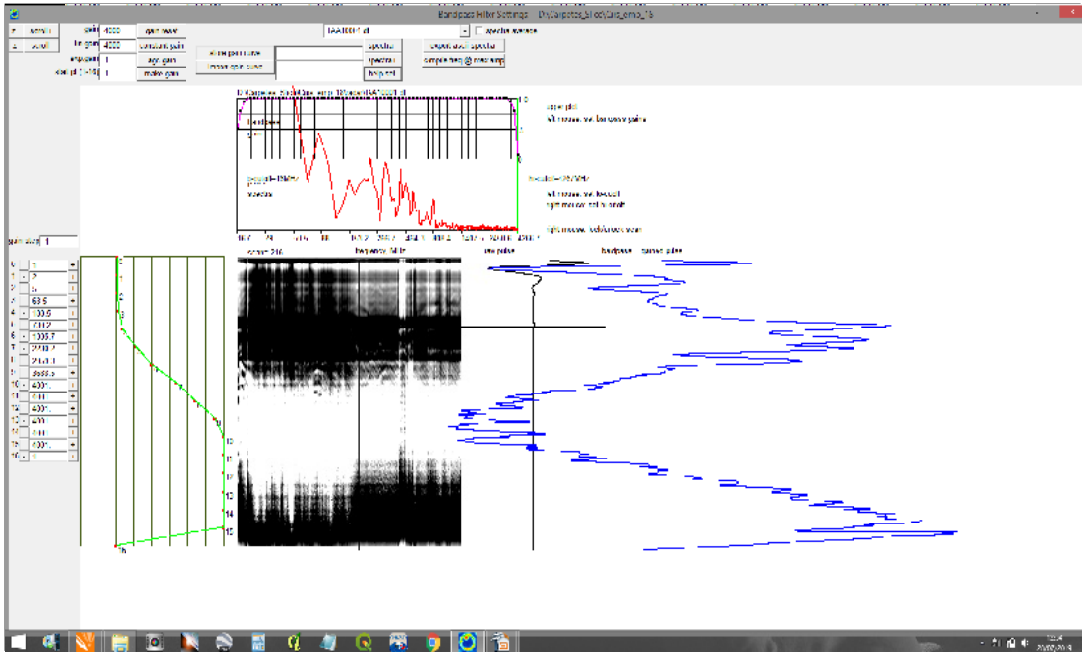


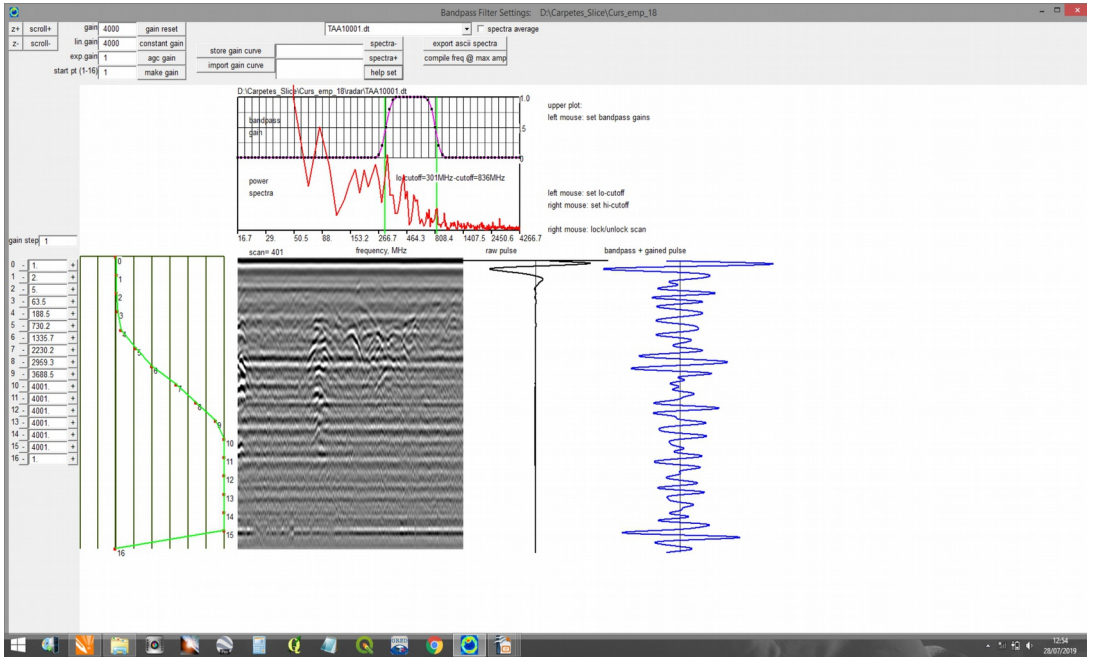
C-GPR SURVEY

-DATA PROCESSING. NOISE AND SHAPE

THE DATA PROCESSING IS USUALLY A SEQUENCE OF TRANSFORMATIONS ON THE ORIGINAL DATASETS BASED ON MATHEMATICAL ALGORITHMS. THE DATA PROCESSING CAN BE OBSERVED AS “CLEANING” DATA FROM NOISES AND ARTIFACTS.



BUT AT THE SAME TIME, THEESE TOOLS ARE USED TO ENHANCE OR ATENUATE REAL DETECTED FEATURES. AT SOME POINT DATA PROCESSING COULD BE A FORM OF DATA INTERPRETATION.

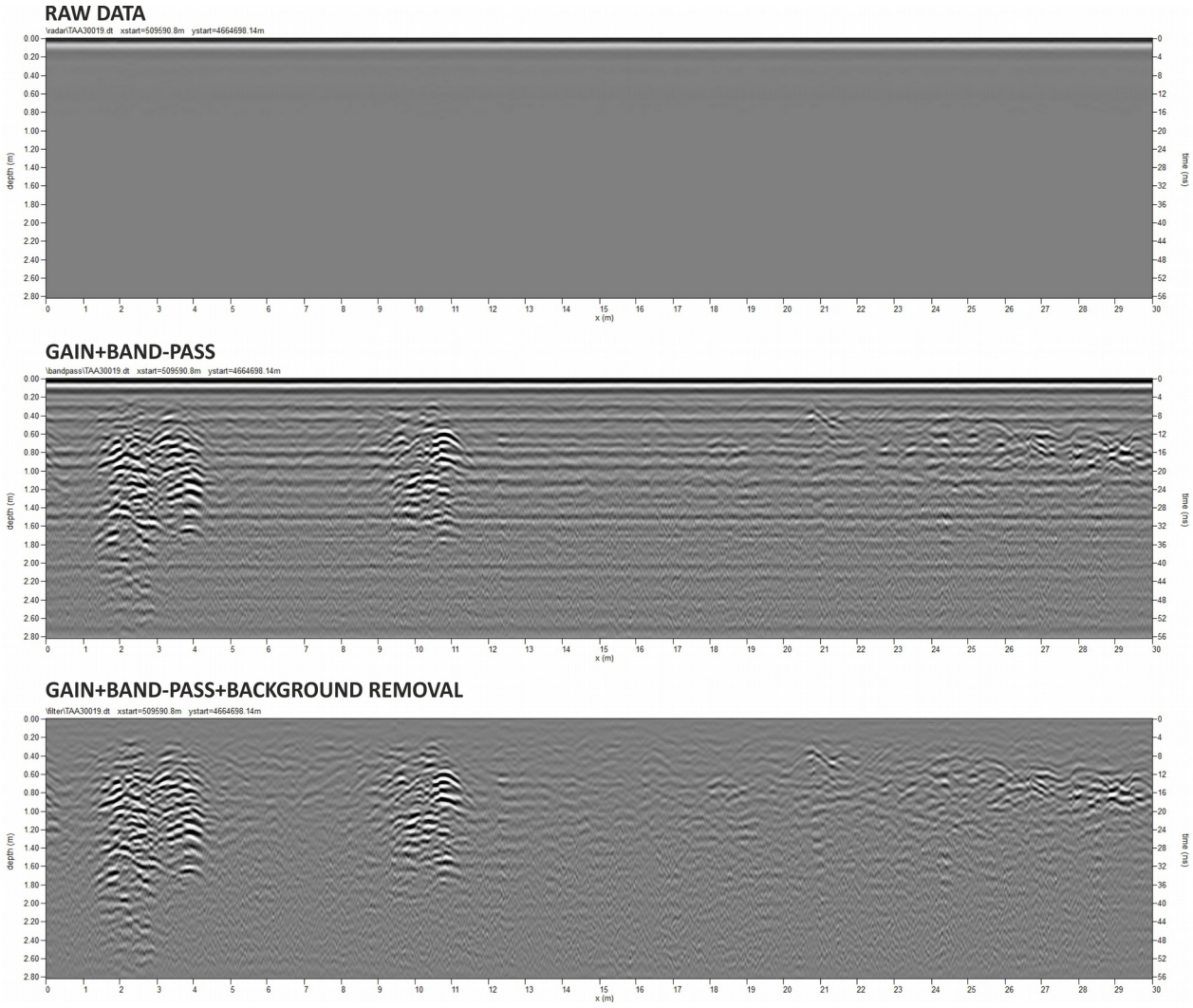


C-GPR SURVEY

-DATA PROCESSING. NOISE AND SHAPE

THE GPR SYSTEMS AND THE ENVIRONMENT PRODUCE NOISES THAT AFFECT DATA QUALITY. SOME OF THAT NOISES ARE WELL CHARACTERIZED, AND GEOPHYSICISTS COULD USE A NUMBER MATHEMATICAL TOOLS TO SEPARATE USEFUL DATA FROM UNDESIRED NOISE.

AS GPR WORKS IN RELATIVE SCALES, THE NOISE RECORDED WITHIN THE DATA TEND TO BE MORE PRESENT AS LOWER IS THE CONTRAST OF THE SOIL MEDIA. **LESS SIGNAL > MORE NOISE TO PROCESS.**



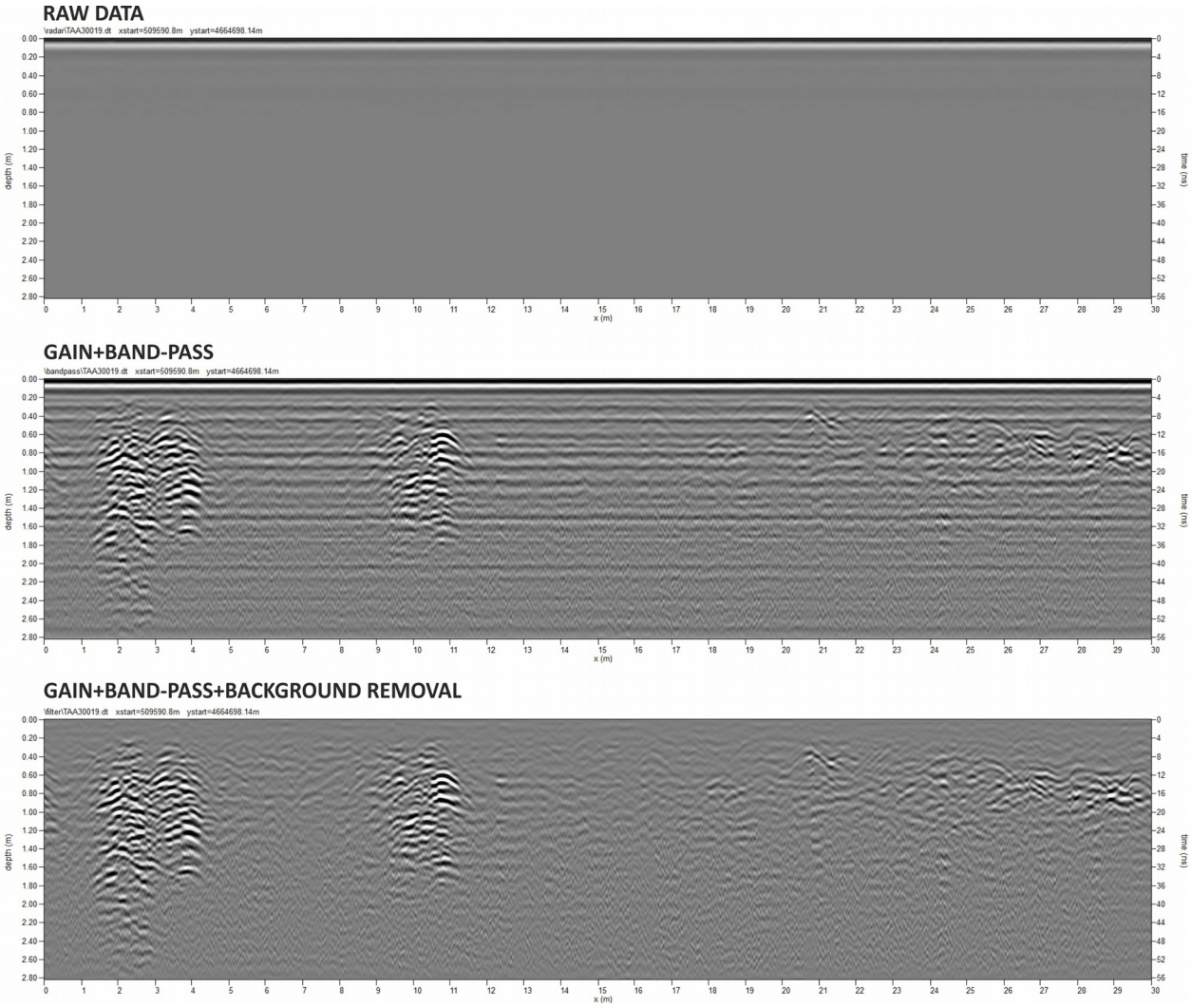
C-GPR SURVEY

-DATA PROCESSING. NOISE AND SHAPE

THE GPR RAW DATA **NEEDS TO BE GAINED** TO COMPENSATE THE DECREASE OF SIGNAL STRENGHT PRODUCED BY ATTENUATION

THE **BAND-PASS FILTERS** ALLOW TO 'CUT' THE FREQUENCY NOISES AND CENTER THE WAVE.

BACKGROUND REMOVAL FILTERS HELP TO ELIMINATE CONSTANT ALTERATIONS PRODUCED BY THE SYSTEM ITSELF, OR AMBIENTAL EMISSION



C-GPR SURVEY

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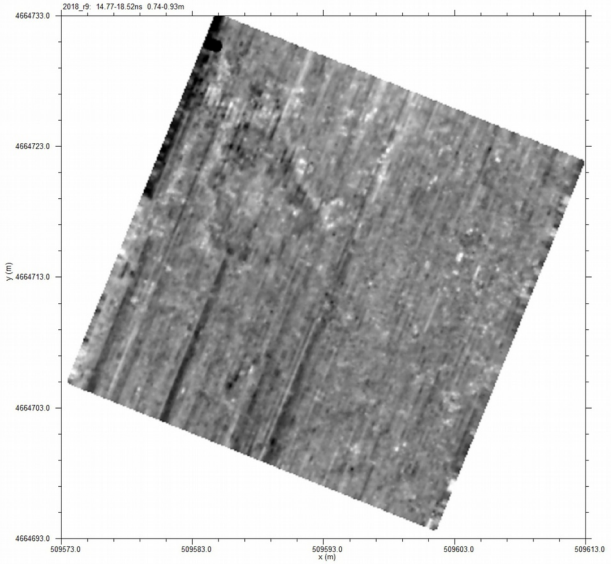
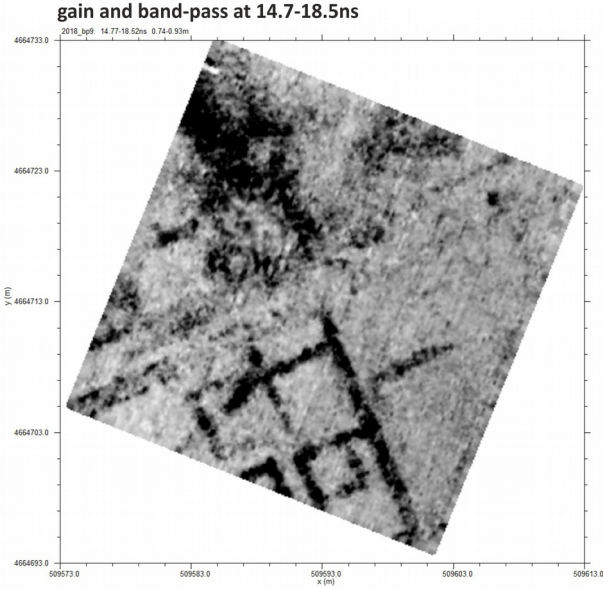
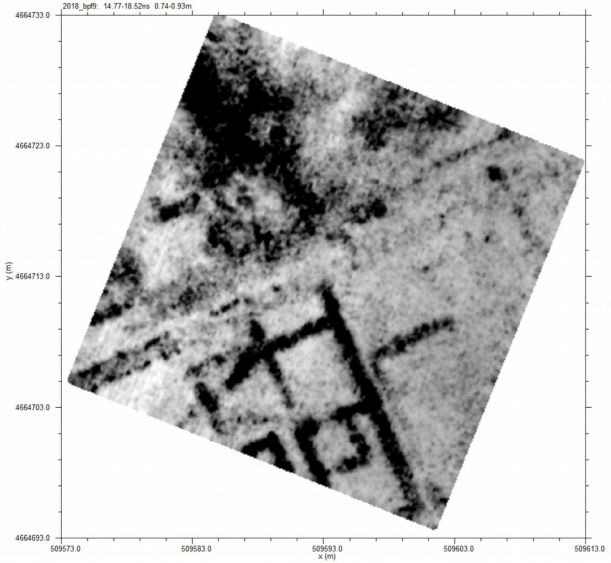
raw data at 14.7-18.5ns



gain and band-pass at 14.7-18.5ns



gain and band-pass + background removal at 14.7-18.5ns

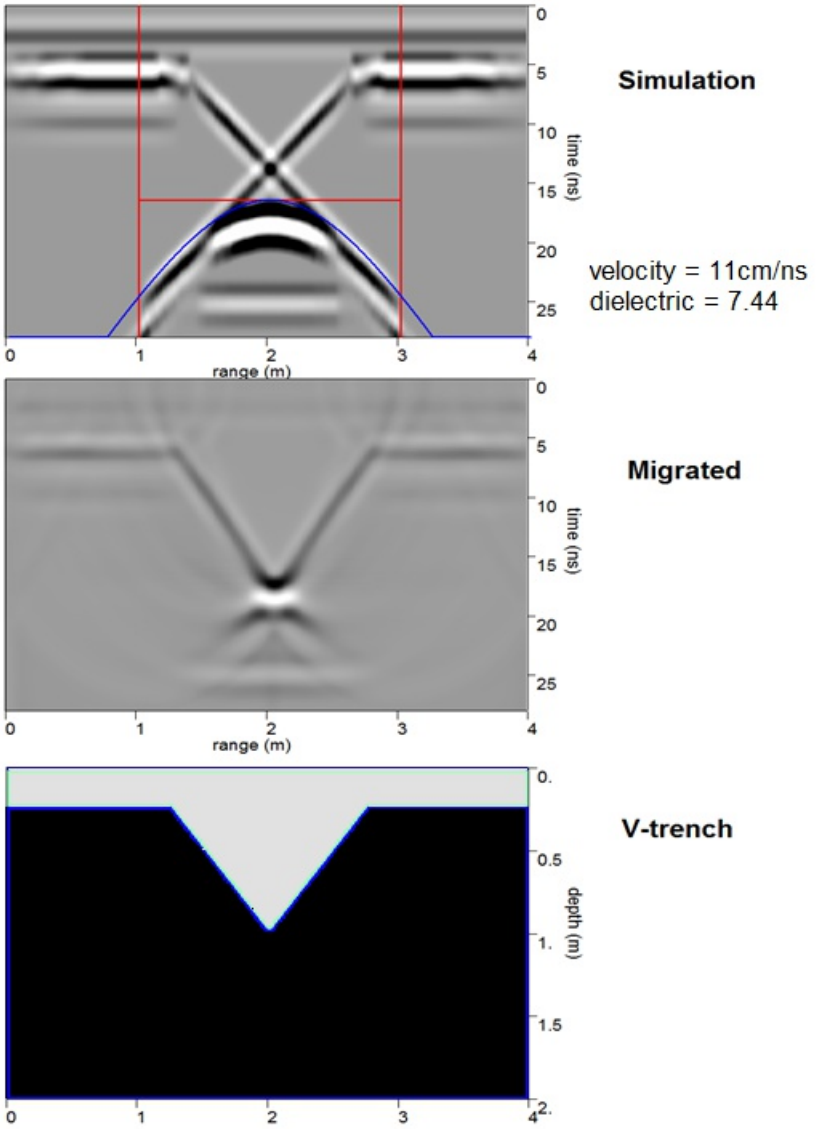


C-GPR SURVEY

-DATA PROCESSING. NOISE AND SHAPE

THE GPR PULSES BEHAVE AS A KIND OF 'LIGHT', AND IN CONSEEQUENCE, THEY ARE SUBJECT TO REFLECTION AND REFRACTION PHENOMENA. ONE OF THE MORE EVIDENT PRODUCTS OF THAT IS HIPERBOLAE PRODUCED BY OBJECTS ON SUBSURFACE.

A NUMERCIAL PROCESS CALLED MIGRATION COULD BE ALSO USED TO REDUCE THE HYPERBOLAS TO THEIR FOCUS. MIGRATION COULD USEFUL TO AVOID THE DEFORMATION OF DETECTED OBJECTS PRODUCED BY HYPERBOLAE TAILS,



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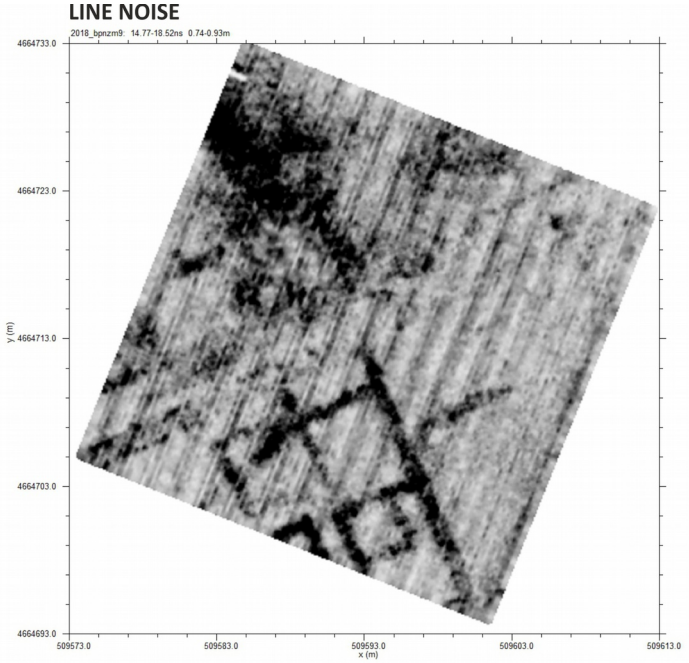
C-GPR SURVEY

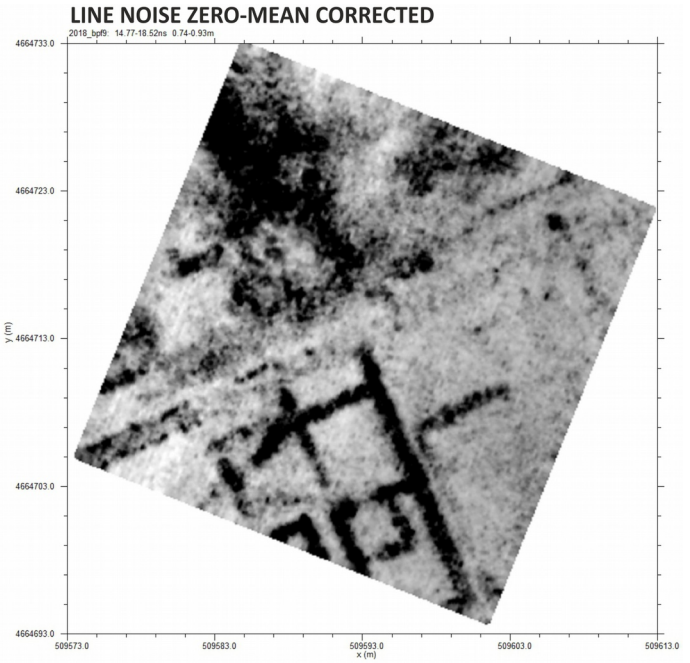
-DATA PROCESSING. NOISE AND SHAPE

CREATION OF TIME-SLICES ALSO NEED SPECIFIC RPOCESSING.

CHANGES IN SOIL CONDITIONS DURING A SURVEY (MOISTURE, TEMPERATURE) COULD PRODUCE DIFFERENCES IN CONTRAST FROM DATA COLLECTED AT START AND END OF THE FIELDWORK.

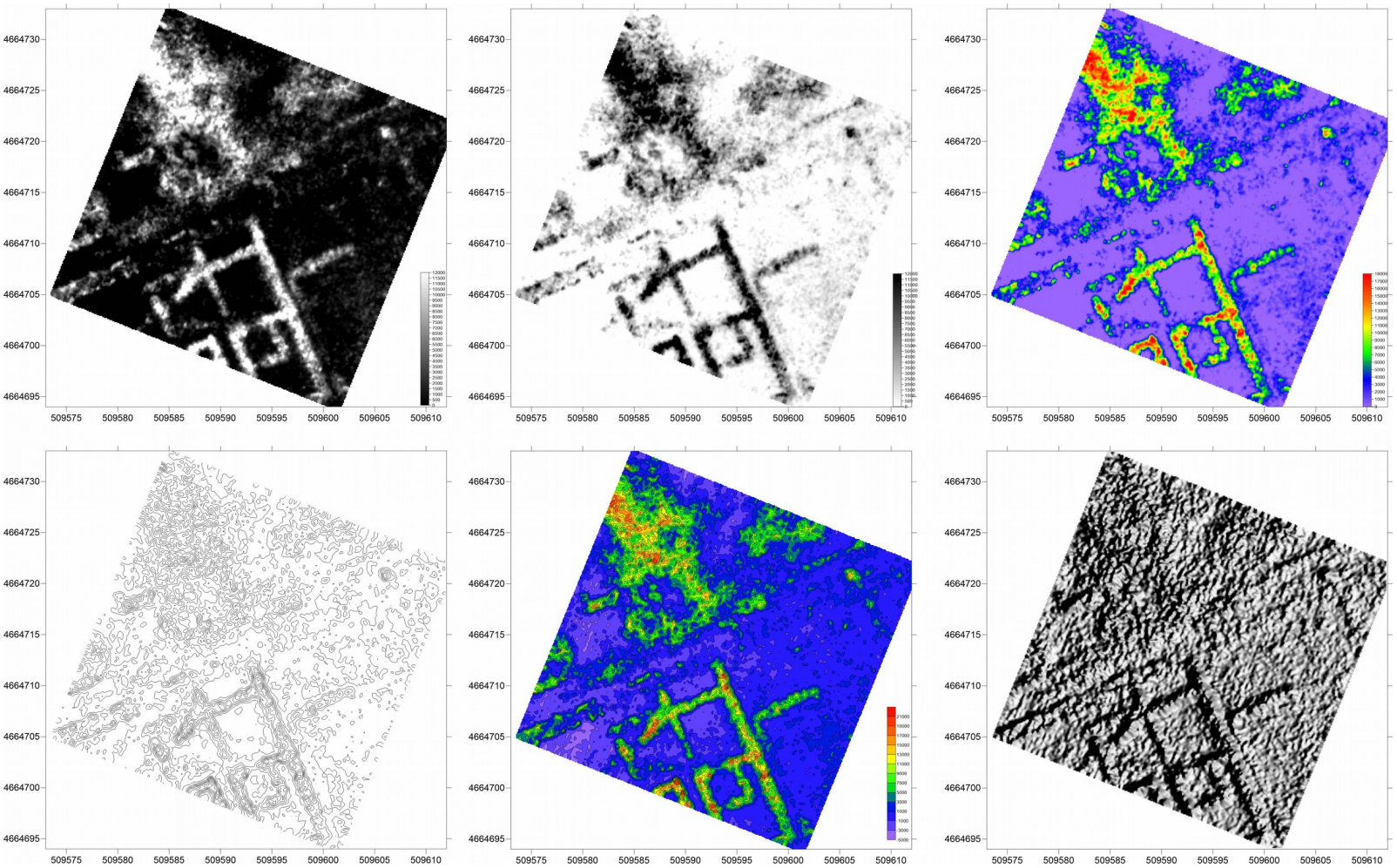
MULTI-CHANNEL GPR REQUIRE TO CORRECT THE DIFFERENCES BETWEEN THE SIGNAL PRODUCED BY DIFFERENT CHANNELS. THEESES DIFFERENCES PRODUCE 'LINE-NOISES' IN THE TIME-SLICE IMAGES





C-GPR SURVEY
-REPRESENTING DATA

REPRESENTATIONS OF DATA ARE THE USUAL FORMS TO COMUNICATE SURVEY RESULTS.
IT CAN BE DONE IN MANY FORMS:



C-GPR SURVEY
-REPRESENTING DATA

SOMEHOW, THE WAY WE REPRESENT A DATASET IS DETERMINED BY OUR VIEW ON DATA. IT'S A KIND OF INTRPRETATION AVANT-LA-LETTRE. WE TRY TO OFFER SHARP AND CLEAR VIEWS OF THE OBJECTS WE CONSIDER RELEVANT FOR ARCHAEOLOGY, (SOMETIMES AT THE PRICE OF LEAVING OTHERS LESS CLEAR).

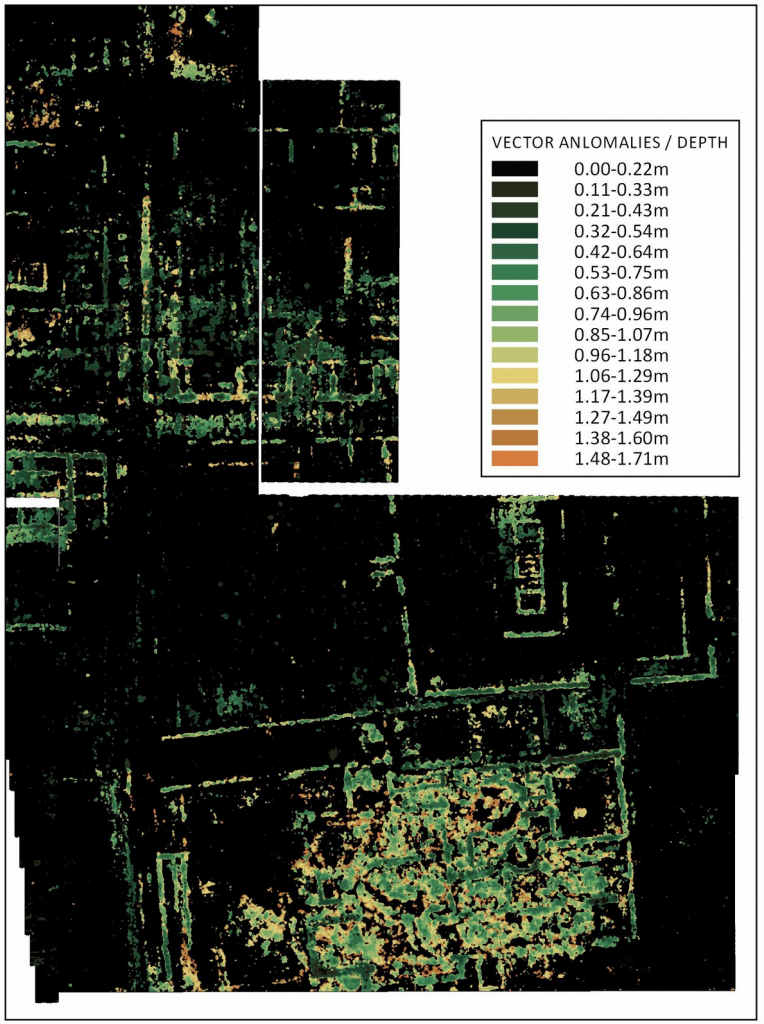
ON TIME-SLICE REPRESENTATION, THE CONTRAST ADJUSTMENT IS USEFUL TO HIGHLIGHT STRUCTURES WITH TIDDFERENT RESPONSES.

TIME-SLICE SEQUENCES HELP TO UNDERSTAND EVOLUTION OF OBJECTS WITH DEPTH

C-GPR SURVEY
-REPRESENTING DATA

THE REPRESENTATION OF DATA IS EQUALLY IMPORTANT BOTH FOR UNDERSTANDING THEM AND TO COMUNICATE. AFTER ALL, THE OBJECTIVE OF A GPR SURVEY IS TO PRODUCE USEFUL ARCHAEOLOGICAL INFORMATION THAT NEEDS TO BE TRANSMITTED TO FINAL USERS (ARCHAEOLOGISTS).

BUT AT THE SAME TIME THE GPR RESULTS COULD NEED TO BE CONDENSED IN OTHER GRAPHICAL FORMATS TO EXPOSE DIFFERENT ASPECTS OF DATA, ESPECIALLY WHEN WORKING ON INTERPRETATION.



D-GPR SURVEY APPLIED TO ARCHAEOLOGY

-PLANNING A GPR SURVEY. CONTEXT, FREQUENCY, DEPTH AND RESOLUTION

-INTERPRETING DATA. UNDERSTANDIG DATA AND ITS CONTEXT

-COMUNICATING RESULTS

D-GPR SURVEY APPLIED TO ARCHAEOLOGY

-PLANNING A GPR SURVEY. CONTEXT, FREQUENCY, DEPTH AND RESOLUTION

GPR IS **NOT ALLWAYS THE BEST METHOD** TO EXPLORE A SITE OR TO ANSWER A SPECIFIC ARCHAEOLOGICAL QUESTION.

THE USE OF GPR OR OTHER SURVEY METHODS SHOULD BE DETRMINED BY A **PREVIOUS EVALUATION WORK**, EXAMINING:

-THE ARCHAEOLOGICAL BACKGROUND
-THE EXPECTED GEOPHYSICAL EXPRESION OF ARCHAEOLOGICAL FEATURES WE WANT TO DESCRIBE
-THE GEOLOGICAL ENVIRONMENT
-THE LOCAL TOPOGRAPHY AND AREA TO COVER
-THE USE AND CONDITIONS OF TOPSOILS
-THE LEVEL OF DETAIL NEEDED
..AND THE AVAILABLE FUNDS

IN THE CASES WHERE GPR APPEARS AS ONE OF THE OPTIONS, SOME ADDITIONAL QUESTIONS MUST BE SOLVED:

-WHICH FREQUNCY/SYSTEM?
-WHICH RESOLUTION?
-SURVEY GOMETRY IS RELEVANT?
-IS THE SURFACE IN GOOD CONDITION FOR GPR?

D-GPR SURVEY APPLIED TO ARCHAEOLOGY

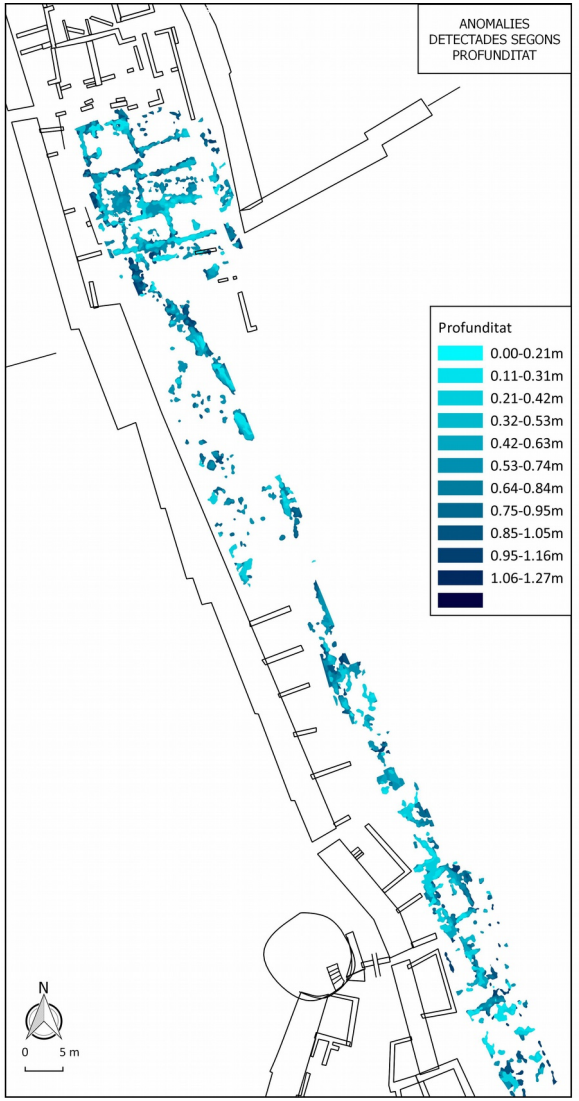
-INTERPRETING DATA. UNDERSTANDING DATA IN ITS CONTEXT

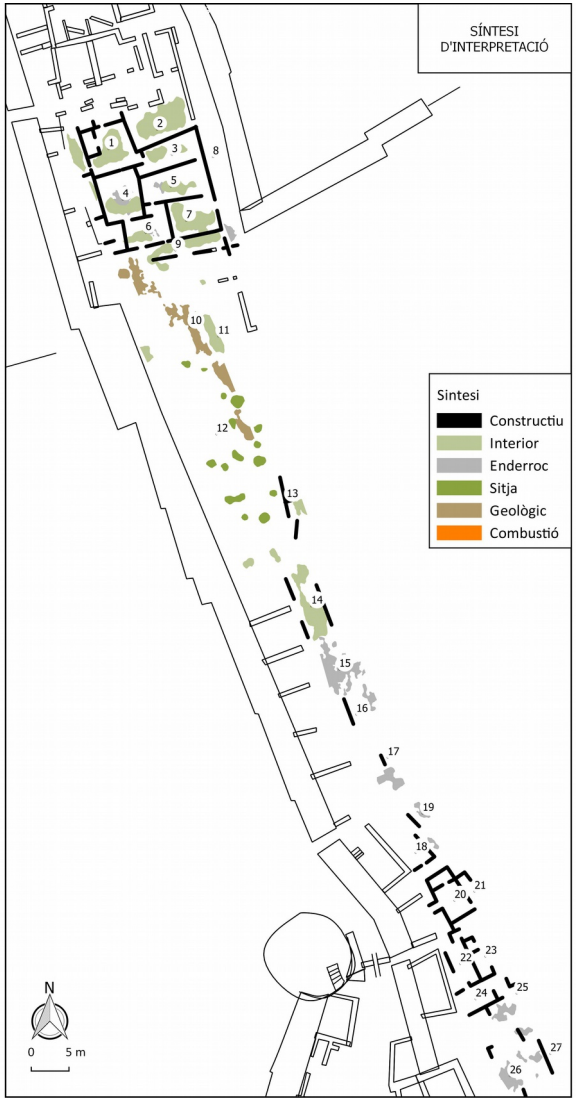
ONCE DATA IS PROCESSED AND PLOTS ARE GENERATED
THE NEXT STEP IS INTERPRETATION.

PROPOSE EXPLANATIONS TO DETCTED ANOMALIES FROM OBJECTIVE DATA TO ARCHAEOLOGICAL EXPLANATION

TAKEN INTO ACCOUNT:

-FREQUENCY/SYSTEM USED
-DATA QUALITY
-OTHER GEOPHYSICAL DATA AVAILABLE
-THE ARCHAEOLOGICAL BACKGROUND
-THE GEOLOGICAL ENVIRONMENT
-THE LOCAL TOPOGRAPHY
-THE USE AND CONDITIONS OF TOPSOILS





D-GPR SURVEY APPLIED TO ARCHAEOLOGY

COMUNICATING RESULTS

INTERPRETATION OF SURVEY RESULTS MUST BE COMUNICATED
TO FINAL USERS OF DATA.

IN EVERY SURVEY, A NUMBER OF ANOMALIES AND DATA HAS MULTIPLE OR NON-CLEAR INTERPRETATIONS

A GOOD COMUNICATION (TEXTUAL, GRAPHICAL) ALLOWS DEBATE AND RE-INTERPRETATION OF DATA
FROM OTHER VIEWS

INTERPRETATION DIAGRAMS ARE USEFUL TO BRING SIMPLIFIED VIEWS ON RESULTS.

… BUT IT'S RECCOMENDABLE KEEPING ALWAYS OPEN TO ALTERNATIVE INTERPRETATIONS

D-GPR SURVEY APPLIED TO ARCHAEOLOGY

COMUNICATING RESULTS:

ARCHAEOLOGICAL SITE OF ALAUNA (VALOGNES, NORMANDY-FRANCE)

D-CONCLUSION

D-CONCLUSION

GPR IS A SURVEY METHOD BASED ON EM WAVE PROPAGATION PRINCIPLES

THE EM PULSES EMITED BY GPR REACT WITH CHANGES IN SOIL DIELECTRIC AND CONDUCTIVITY

THE EM PROPRIETIES OF SOIL (AND ARCHAEOLOGICAL OBJECTS) COULD CHANGE DEPENDING ON ENVIRONMENTAL CONDITIONS.

GPR COULD PRODUCE HIGH-DETAIL IMAGES OF BURIED REMAINS, BUT NOT IN EVERY MEDIA, NOT IN EVERY ENVIRONMENTAL CONDITIONS.

GPR 2D DATA (SINGLE PROFILES) COULD BE COMBINED IN 3D VOLUMES. THIS ALLOWS TO GENERATE Z PLANES AT DIFFERENT DEPTHS. A GOOD COMUNICATION FORMAT.

AS OTHER GEOPHYSICAL METHODS, GPR SURVEY NEEDS INTERPRETATION. INTERPRETATION SHOULD INTEGRATE THE BACKGROUND KNOWLEDGE WITH OBJECTIVE DATA.

GPR SURVEY DATA IS HIGHLY COMPLEMENTARY WITH OTHER GEOPHYSICAL DATA

THANKS FOR YOUR ATTENTION!